بسمـــ الله الرحمن الرحيمـــ

فريق عمل كل الطب

يُقدمـــ

سلسلة كتب د/أحمد موافي

In Capsule Series

تم الرفع بواسطة فريق عمل كل الطب

ALLTEB MEDICAL TEAM

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In Capsule Series

Internal Medicine

NEPHROLOGY

First edition

By :

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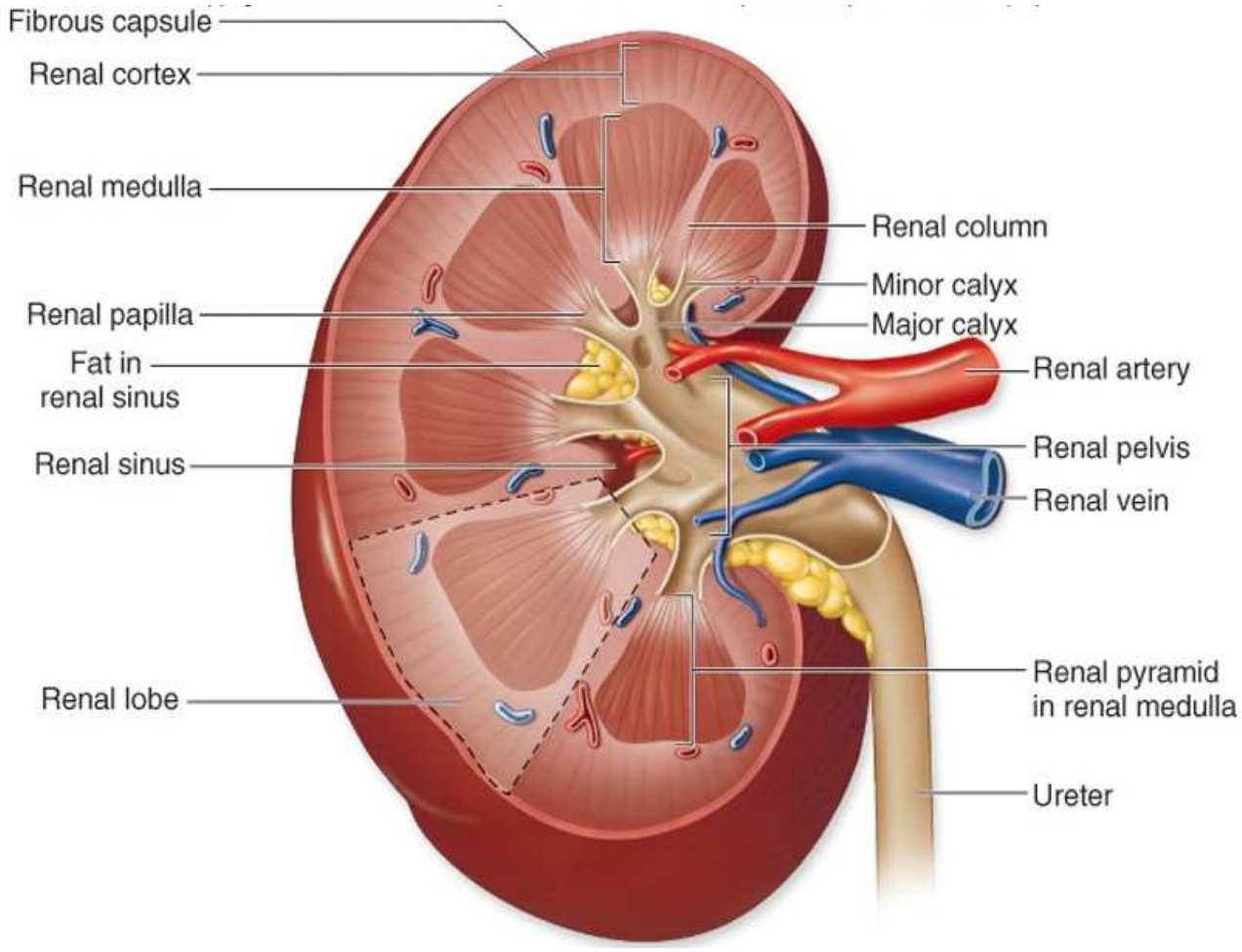
Index

Introduction ……1
Investigations of renal diseases……..3
Normal urinalysis ……6
Drugs & kidney ……7
Chronic renal failure ……9
Acute renal failure ……18
Nephrotic syndrome ……26
DD of Polyuria……..31
Nephritic syndrome ……..32
DD of Hematuria ……..36
Glomerulonephritis (GN) ……..37
Lupus nephritis……40
Metabolic alkalosis……..41
Metabolic acidosis……42
Hypo & HyperKalemia ……..43
Hypo & HyperNatremia ……..46
pyelonephritis…….. 48
value of urine examination……53
proteinuria ……..55
nephrology MCQ ……..59

INTRODUCTION

Anatomy :

- There are 2 kidneys , they are bean shaped and reddish brown.
- They are located between the peritoneum and the posterior wall of the abdomen.
- Dimensions : 4 x 2 x 1 inches.
- **Layers :**

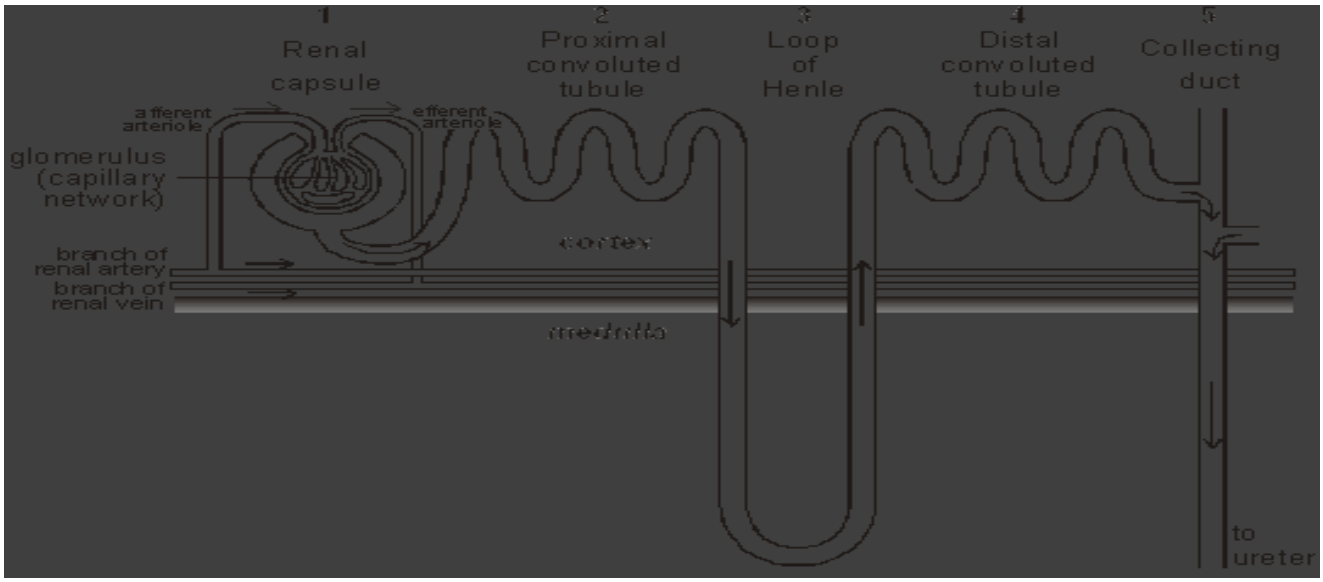


- **Cortex:** superficial layer.
- **Medulla :** Inner portion , arranged in pyramids , there are 8 – 18 pyramids per kidney separated by renal columns. The apex of each pyramid extends toward the renal pelvis and forms a papilla which projects into minor calyces → major calyces, which in turn unite to form renal pelvis.

The nephron : the functional unit of the kidney

There are approximately one million nephrons in each kidney.

The number of nephrons is constant from birth.



It consists of :

1. Renal corpuscle : Bowman's capsule & the glomerulus within it : It is the site of filtration of the blood.
2. Proximal convoluted tubule.
3. Loop of henle.
4. Distal convoluted tubule.
5. Collecting duct : drains into the renal pelvis.

Renal blood flow :

- The kidneys get 20 - 25 % of cardiac output.
- Renal artery divides to form interlobar arteries (*that run between the medullary pyramids*) → arcuate arteries (*run in the corticomedullary junction*) → interlobular arterioles (*run in the cortex*) → Afferent arterioles → Glomeruli → Efferent arterioles which divide into the vasa recta and the peritubular capillaries , this is a network of capillaries which allows movement of fluids and solutes out of the tubules.
-

Functions :

- Regulation of water & electrolyte balance.
- Regulation of acid base balance.
- Excretion of water soluble waste : urea , uric acid , creatinine , drugs ……
- Endocrine : Renin – angiotensin system , erythropoietin , vitamin D activation.

Glomerular filtration rate :

- It is the volume of fluid filtered from the renal glomerular capillaries into Bowman's capsule per minute.
- In an average man : GFR = 125 ml/min.
- In women : 10% less than those of men.
- Clinically , GFR is often measured to determine the renal function.
- Although the GFR is about 180 L / day , our urine output is only 1-2 L/day (*which is good or else we'd spend the day in the bathroom* ☺)

INVESTIGATIONS OF RENAL DISEASES

Aim :

a) To prove the condition.
b) To asses the severity.
c) Investigation for the cause.

1- **Urine investigations :**

- Urinalysis : physical , chemical , microscopic (details : see later)
- Urine culture & sensitivity : for UTI

2- **Blood investigations :**

- CBC.
- Na , K , Ca , P .
- Urea , Creatinine , PH

Na	: 135 - 145 mEq/L
K	: 3.5 - 5 mEq/L
Ca	: 8.5 - 10.5 mg %
P	: 2.5 - 4.5 mg %
HCO_3	: 22 - 26 mEq/L
PH	: 7.36

3- **Renal function test :**

For glomerular function : Measurement of :

i. **Serum Creatinine** (N : 0.7 - 1.4) :

- It is produced from muscle cells at a constant rate , so its plasma concentration depends on its excretion, which reflects GFR.
- Small change in creatinine are associated with large change in GFR, and so plasma creatinine is an insensitive marker of early renal disease.

ii. **Blood urea** (N : 20 - 40 mg%) :

Less reliable as it is affected by dietary protein & liver failure.

iii. **Creatinine clearance :**

Volume of plasma which is cleared from creatinine in one minute.

$$\text{Creatinine clearance} = \frac{U_{cr}\ (\text{urine cr}) \times V\ (\text{volume of urine ml/d})}{P_{cr}\ (\text{plasma creatinine}) \times 24 \times 60}\ \text{ml/min}\ (\text{N : 80 - 125 ml/min})$$

Cockcroft-Gault equation :

$$\text{Creatinine clearance} = \frac{(140 - \text{age}) \times \text{weight (kg)}}{\text{serum Cr} \times 72}\ (\text{if female} \times 0.85)$$

Others :

- Inulin clearance : inulin is a small molecule, freely filtered by the glomeruli , & with no tubular secretion.
- Chromium-labelled EDTA.

For tubular function :

- Specific gravity & urine osmolality.
- Urine concentration test.
- Urine dilution test .

4- **Renal imaging :**

i. Plain X-ray of urinary tract.

ii. Renal ultrasound : it demonstrates

a) Bipolar renal length (8.5 - 13.5 cm) :

- In CRF : the kidneys are small. The exceptions are : **MCQ**
  - Polycystic kidney disease : large with multiple cysts.
  - Diabetic nephropathy , Amyloidosis : **normal** size.
- In ARF : the kidneys are normal size , enlargement may occur due to swelling.

b) Doppler ultrasound is useful to assess renal blood flow.

c) Renal stones, mass lesions , cysts.

iii. Intravenous urography (IVU) & ascending pyelography.

iv. CT , MRI .

v. Isotope renography *(e.g. MAG_3 , Hippuran , DTPA)*

vi. Renal biopsy.

5- **Investigations for the cause**

Addiction-Free Nation *Program should consider* ***in capsule series*** *its 1st priority, as it has been proved that almost all internal medicine seekers are addicted to it.*

dr. Alsayed Dawoud
Kasr-Alainy School of Medicine

NORMAL URINALYSIS

Physical properties :

- Volume /24h : 800 1500 ml.
- Specific gravity : 1015 - 1025
- Color - Aspect : Amber yellow - clear.
- PH : Acidic , average 6

Chemical properties :

- Proteins : Nil or trace (< 150 mg/ 24h)
- Glucose : Nil
- Ketones : Nil
- Bilirubin , Bile salts : Nil
- Urobilinogen : trace.

Microscopic :

- RBCs : 0 - 5 H.P.F. (*high power field*)
- Pus cells : 0 - 5 H.P.F.
- Crystals : Nil or + (few oxalate)
- Casts : Nil or hyaline cast.

DRUGS & THE KIDNEY

Drugs induced impairment of renal functions : *MCQ*

a) **Pre renal :** hemodynamic kidney injury (Impaired perfusion of the kidneys)

- ACEIs : via dilatation of efferent ⇨ ↓ interglomerular pressure ⇨ ↓ GFR particularly in the presence of renovascular disease.
- NSAIDs : inhibition of vasodilatory prostaglandin synthesis ⇨ intrarenal VC.

b) **Renal :**

Acute tubular necrosis : A M (**A**hmed **M**owafy) ☺

- Antibiotics : **Am**inoglycosides (gentamicin , streptomycin) , **Am**photericin B.
- Heavy metals : **A**rsenic , **M**ercury.
- **Am**phetamines IV.
- Radiographic contrast media.

Glomerulonephritis :

Morphological lesion	Causative agent
Minimal change GN	NSAIDs Ampicillin. Interferon.
Membranous GN	Gold. Penicillamine.
Focal segmental GN	Heroin.
Proliferative GN	Allopurinol. Penicillin. Sulfonamide. Amphetamine IV
Rapidly progressive GN	Amoxicillin Penicillamine. Carbimazole. Warfarin.

Acute tubulointerstitial nephritis :

Caused by hypersensitivity reaction to drugs

- NSAIDs.
- Penicillin.
- Sulphonamides.

Chronic tubulointerstitial nephritis :

- NSAIDs (analgesic nephropathy)

Nephrogenic DI : Lithium.

c) **Post renal :**

Urinary tract obstruction :

- **Crystal formation :**
  - Acyclovir.
  - Chemotherapy : Uric acid crystals forming as a consequence of tumor lysis .

- **Retro-peritoneal fibrosis :**
  - Methysergide.

Drugs eliminated mainly by the kidneys :

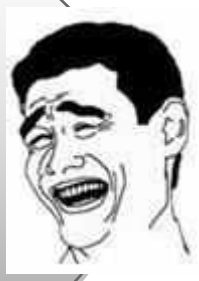
may accumulate in patients with low GFR leading to toxic effect e.g.

- Digoxin : arrhythmias.
- Erythromycin : encephalopathy.
- Lithium : arrhythmias , seizures.
- Penicillins & cephalosporins: encephalopathy

Acute renal failure

These items will be discussed :

- Definition :
- Etiology : 3 X 3
- Pathophysiology : 3 stages
- Clinical picture :
- Investigations : 5
- Treatment : 3 D + Transplant



Definition :

- ARF is a clinical syndrome characterized by a **r**apid (days to week) deterioration of renal function with or without oliguria. It is usually **r**eversible with treatment of the cause.
- Notice that patients with ARF may have a normal urine volume.

Synonyms : Acute kidney injury (AKI).

Etiology : 3 X 3 (3 Pre-renal, 3 Renal, 3 Post-renal)

I. **Pre-renal :** ↓ renal perfusion
   1. Hypovolemia : Hemorrhage, dehydration, burns, cardiogenic shock (↓ COP).
   2. Renal artery stenosis.
   3. Hepato-renal syndrome.

II. **Renal (Intrinsic) :**
   1. Tubular :
      - **Acute tubular necrosis** (ATN) : The most common cause.
      - Acute interstitial nephritis (AIN)
      - Acute papillary necrosis : DM, Sickle cell anemia.

2. Glomerular : Rapidly progressive GN, Lupus nephritis.
3. Renal vessels : Malignant hypertension, PAN, DIC, Thromboembolism, Scleroderma.

III. **Post-renal :** urinary outflow obstruction e.g.

1. Bilateral ureteric obstruction.
2. Unilateral ureteric obstruction with contralateral non functioning kidney.
3. Obstruction of the bladder or urethra.

Acute tubular necrosis

Causes :

I. **Ischemic :** Prolonged pre-renal cause for ARF ➝ Tubular ischemia & necrosis.

II. Toxic :

- Antibiotics: **Am**inoglycosides, **Am**photercin B
- Bilirubin, Hemoglobin, Myoglobin. ♫ ♫
- NSAIDs.
- Radio-contrast dye.
- Heavy metals: **A**rsenic, **M**ercury.

Pathophysiology : 3 stages

I- Oliguric phase : *Lasts few hours to weeks*

➲ Oliguria (↓ urine output < 400 cc/d) due to :

a. Obstruction of tubules by epithelial casts.
b. Afferent vasoconstriction due to excess renin activation.
c. Back-leak of tubular fluid to renal interstitium.

➲ **Na :** decreased (dilutional hyponatremia)

➲ K : Hyperkalemia.

➲ Phosphorous : ↑

➲ Ca : ↓ or may still normal.

➲ H^+ ions, urea & creatinine : ↑

Disturbances in Ca, Phosphorous & renal anemia are less prominent than in CRF.

II. Diuretic phase :

- Polyuria in this phase - in one word - is due to **partial** recovery of the tubules.
- The anatomy is corrected (No obstruction, no back leak), but the physiology is not (The kidney tubules still unable to concentrate urine).
- The urine output increases (up to 10 L/d) but it may take several days before the creatinine starts to drop due to persistent afferent VC in the early diuretic phase.
- Dehydration & hypokalemia may occur.

III- Post diuretic phase (Convalescent phase) : may takes weeks or months.

Here, there is complete recovery with improvement of the general health & normalization of the chemistry.

Clinical picture :

I. Oliguric phase : Lasts few hours to weeks

1. Oliguria : ↓ urine output < 400 cc/d.
2. Manifestations of hypervolemia :
   - Headache.
   - Congested neck vein.
   - Pulmonary edema.
   - Hypertension.
   - Edema lower limb.
3. Manifestations of hyponatremia : **C**onvulsion, **C**onfusion, **C**oma.
4. Manifestations of hyperkalemia :
   - ☠ Skeletal muscle : weakness, flaccid paralysis, areflexia.
   - ☠ Smooth muscle : Intestinal colic, nausea, vomiting.
   - ☠ Cardiac muscle :
     - ECG changes : " see later "
     - Arrhythmias & can progress to cardiac arrest.

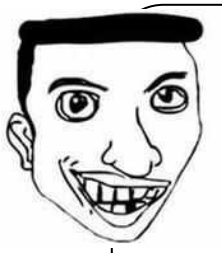
Causes of ↑ respiratory rate in ARF :

- Compensation of metabolic acidosis.
- Pulmonary edema.

In ARF : remember these 3 "No"

- **No** Bone manifestations.
- **No** endocrinal manifestations.
- **No** or mild anemia.

5. Manifestations of acidosis : Rapid deep respiration.
6. Manifestations of uremia : ABCD
   - **A**norexia, nausea, vomiting.
   - **A**sterixis.
   - **P**ericarditis, **B**leeding.
   - **C**onvulsion, **C**onfusion, **C**oma.
   - **D**eath.



Causes of death :

- Pulmonary edema.
- Cerebral stroke.
- Bleeding.
- Infections.

II. Diuretic phase : Dehydration & hypokalemia may occur.

III. Post diuretic phase (*Convalescent phase*) :

- Improvement of the general health & normalization of the chemistry.
- It may takes weeks or months.

Investigations :

Aim :

- To prove the condition.
- To assess the severity.
- To search for the cause.

1- Urine examination :

a) Volume : Oliguria (< 400 cc/d). Anuria is characteristic of post-renal causes.

b) Specific gravity : **Fixed** (1010)

c) Casts :

- Muddy-brown granular cast : in ATN.
- Pigmented cast in myoglobinuria.
- White cells cast in AIN.

d) Urine Na : to differentiate pre-renal causes from ATN.

- Pre-renal causes : urine Na < 20 mEq/L.
- ATN : urine Na > 40 mEq/L.

e) Fractional excretion of Na (FE_{Na}):

$$FE_{Na} = 100 \times \frac{\text{sodium}_{\text{urinary}} \times \text{creatinine}_{\text{plasma}}}{\text{sodium}_{\text{plasma}} \times \text{creatinine}_{\text{urinary}}}$$

- Pre-renal causes : < 1%
- ATN : > 2%

Fractional excretion of other substances can be measured to determine renal clearance e.g. urea. These can be used in patients undergoing diuretic therapy, since diuretics induce a natriuresis. Thus, the urinary sodium concentration and FENa may be higher in patients receiving diuretics in spite of prerenal pathology.

2- <u>Blood examination :</u> (= Pathophysiology)

- Na : ↓ (dilutional hyponatremia)
- K : ↑
- PO_4 : ↑
- H^+, urea, creatinine : ↑

Disturbances in Ca, Phosphorous & renal anemia are less prominent than in CRF.

3- <u>Renal function tests</u> : impaired

- Azotemia : ↑ Urea & creatinine.
- Creatinine clearance : ↓

4- <u>Ultrasound</u> : Normal diameter.

5- <u>Investigations for the cause :</u> e.g.

- Rerograde pyelography & angiography.
- Plain film of the abdomen : to detect the stones.

Treatment :

I. Prophylactic.

II. Curative.

III. Conservative : 3 D + T

I. Prophylactic treatment :

- Avoid nephrotoxic drugs as possible.
- Avoid radio-contrast dye in a case of DM.

II. Curative treatment :

1. Urinary catheter : to assess urine volume & to exclude post-renal cause.
2. Central venous catheter : to assess the blood volume.
3. Immediate volume infusion to prevent ATN.
4. **D**iuretics (Lasix) : ??

   There is a little or no chance of ↑ urine output.
5. **D**opamine : ??
   - Dose : renal dose : 2mg/kg/min → renal VD. S/E : Bowel ischemia, ↓ TSH.
   - Recently, some consider that the use of dopamine in ARF is a *bad medicine*.

III. Conservative treatment : 3D + T

I. Diet :

- H_2O : ↓
- Na :↓
- K :↓
- Protein : ↓ (40 gm/d)

II. Drugs : (just symptomatic treatment) 7 H & 3A

1- Hypervolemia : Lasix infusion.

2- Hypertension : **A**CEIs, **β** blocker , **C**a channel blocker or **D**iuretic.

3- Heart failure : **Di**lator , **Di**gitalis (small dose) , **Di**uretic.

4- Hyperkalemia : ACID

a) **A**cidosis correction : $NaHCO_3$.

b) **C**a gluconate (slowly infusion)

c) **I**nsulin + glucose → intracellular shift of K.

d) **D**ialysis.

5- Hyperphosphatemia : Phosphate binder : AL hydroxide, Ca carbonate.

6- Hypocalcemia : Ca gluconate.

7- H^+ : $NaHCO_3$.

8- Anemia :

- Erythropoietin (*Eprex*) : 4000 u 2 times / week.
- Packed RBCs, Iron.

9- Antibiotics : For infectins.

10- Anorexia, nausea, vomiting : domperidone *(motilium)*

III. Renal replacement therapy : Dialysis and renal transplant.

Indication of dialysis in patients with ARF :

A. Clinical :

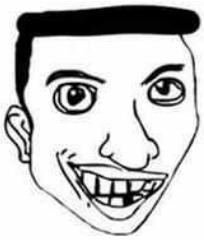
- **A**cute Pulmonary edema.
- **P**ericarditis.
- **P**ersistent diarrhea.
- **P**reoperative.
- **C**oma.
- **C**onvulsion.
- **D**eterioration of general health.

B. Laboratory :

- Urea : > 200 mg/dl (N : 20 - 40 mg/dl)
- Creatinine : > 8 mg/dl , > 7 in DM (N : 0.7 - 1.2 mg/dl)
- K : > 7 mEq/L . (N : 3.5 - 5.5 mEq/L)
- HCO_3 : < 14 mEq/L .
- PH : < 7.2
- Hypercatabolic RF :
  - Creatinine ↑ by > 1mg/d.
  - K ↑ by > o.8 mEq/d.

Treatment of diuretic phase :

- Adequate fluid to avoid dehydration.
- High salt & high K.



Indications of renal biopsy in a case of ARF :

- Unclear etiology.
- If no recovery after 3-4 weeks. Severe cases of ATN may be associated with **cortical necrosis** which carries poor prognosis & the patient is converted to a chronic dialysis program.

Chronic renal failure

These items will be discussed :

- Definition :
- Etiology : 12
- Pathophysiology : 8
- Clinical picture : 8
- Investigations : 5
- Treatment : 3 D + Transplant

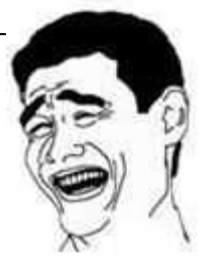
Definition :

Gradual irreversible deterioration of renal function.

Etiology : 12

- **Chronic pyelonephritis** (history of fever , dysuria , loin pain). The most common
- **Chronic GN .**
- DM (diabetic nephropathy)
- Hypertension.
- Gout.
- Hyperparathyroidism.
- Collagen diseases.
- Congenital : polycystic kidney.
- Secondary amyloidosis.
- Obstructive uropathy. (stones)
- Iatrogenic (e.g. NSAIDs)
- Idiopathic.

DM & HTN are the most common causes worldwide, but in Egypt, Chronic pyelonephritis & chronic GN are the most common causes.



Pathophysiology :

1. **H2O :**

   Polyuria (mild , 2.5 - 3 L/d) due to :

   - Hyperdilatation of the residual nephrons.
   - Retention of urea (osmotic dieresis)

2. **Na :**

   - Hyper in 80% of cases : due to ↑ of renin , angiotensin - aldosterone system)
   - Hypo in 20% of cases : due to failure of Na reabsorption as a result of tubular damage. (*Na losers*)

3. **K^+ :**

   - Excretion of K is an easy function so the K level is usually **normal**.
   - Hyperkalemia : may occur in end stage renal failure & in cases of severe acidosis.

4. **Po4 :** ↑↑

5. **Ca :** ↓ then normal then ↑ in end stage

   WHY ?

   Po4 X Ca = constant ……Ok

   Here Po4 is increased , so ….

   - **At first** Ca is decreased due to hyperphosphatemia (↑ Po4 → ↑ Ca excretion) & ↓ vit D activation by the kidney.
   - Hyperphosphatemia → ↑ PTH (*parathormone hormone*) as hyperphosphatemia is the main stimulus of PTH → ↑ Ca up to normal
   - At end stage chronic renal failure : persistent hyperphosphatemia → persistent hyperparathyroidism (3ry hyperparathyroidism) → persistent elevation of Ca exceeding the normal level.

6. **H^+ :** ↑ (acidosis) Due to :
   - Incomplete HCO_3 reabsorption.
   - ↓ formation of urinary buffers.



No tetany in CRF inspite of hypocalcemia : because acidosis will increase the ionized Ca.

7. **Urea :** ↑↑
8. **Creatinine :** ↑↑

Clinical picture : 8

- Because of high reserve of the kidneys , symptoms don't appear until renal function (GFR) declines to 30 % of normal.
- More than 30% of normal GFR : biochemical evidence of renal failure can be seen but patients are generally still asymptomatic.

1. GIT : (due to the effect of uremic toxins)

a) **Mouth :**
   - Amonia smell in the mouth with bad taste sensation.
   - Stomatitis.
   - Dry mouth & tongue.

b) **Esophagus :** GERD

c) **Diaphragm :** Hiccough due to central effect of uremic toxins e.g. phenol.

d) **Stomach :** gastritis up to bleeding & perforation.

e) **Liver :** hepatitis.

f) **Intestine :**
   - Constipation.
   - Late **uremic dysentery** : due to urea deposition in the colon.

2. Cardiac :

a) **Blood pressure :**

- Usually hypertension (80% of cases) : due to Na retention.
- Hypotension in 20 % of cases (Na losers)

b) **Myocarditis** → Heart failure.

c) **Uremic pericarditis** :

- It indicates end stage renal disease . ***Dialysis is indicated***.
- Usually painless pericarditis.
- May be due to uremic toxins ??

d) **Arrhythmia :** due to electrolyte disturbance.

3. Chest :

a) **R**ecurrent chest infections : pneumonia , TB , bronchitis).

b) **R**apid deep respiration : due to acidosis.

4. CNS :

- Psychiatric symptoms : depression , Irritability , Schizophrenia.
- Insomnia , headache.
- Loss of **C**oncentration , **C**onvulsion , **C**oma.
- Neuropathy , myopathy , mythenia.
- Stroke.

5. Skin :

a) **P**allor & earthy look.

b) **P**igmentation.

c) **P**ruritis : due to ↑ PO4 , ↑ PTH , calcification & urea frost.

d) **P**urpura & bleeding tendency due to thromboasthenia.

6. Bone : (***Renal osteodystrophy***)

i. Osteoporosis.
ii. Osteomalacia.
iii. Osteosclerosis.
iv. Ostitis fibrosa cystica.

The etiology of renal osteodystrophy is still questionable , most probably due to 2 mechanisms : 2ry hyperparathyroidism & inactivation of vitamin D.

7. Blood :

a) Anemia : due to
   - ↓ Erythropoietin.
   - Blood loss e.g. bleeding , dialysis.
   - ↓ life span of RBCs.
b) Platelet dysfunction (*thromboasthenia*) : Bleeding tendency.
c) WBCs dysfunction : Recurrent infections .

8. Endocrinal & metabolic :

Endocrinal :

- 2ry & 3ry hyperparathyroidism : due to persistent hyperphosphatemia.
- 2ry hyperaldosteronism.
- Inactivation of vit D → Osteomalacia.
- ↓ production of renal hormones e.g. erythropiotein, testosterone.
- Insulin : 2 types of abnormalities may occur :
  - Hyperglycemia : due to insulin resistance (end organ dysfunction)
  - ↓ Insulin requirement in diabetics due to ↓insulin clearance.
- ↓ metabolic clearance of hormones e.g. insulin, FSH, LH, GH, Prolactin.
- ↓ conversion of T4 to T3 (hypothyroidism).

Metabolic :

- CHO metabolism : see above
- Fat : Impaired clearance of triglycerides → ↑ TG, ↓ HDL
- Protein : ↑ catabolism → wasting of the muscles , gout.
- Electrolytes : see Pathophysiology.

Investigations :

Aim :

- To Prove the condition.
- To assess the severity.
- To search for the cause.

1- Urine examination :

a) Volume : Mild polyuria (*2.5 - 3 L/d*)

b) Specific gravity : **Fixed** (1010)

c) Casts : Broad casts (specific) , granular casts (not specific).

2- Blood examination : (= Pathophysiology)

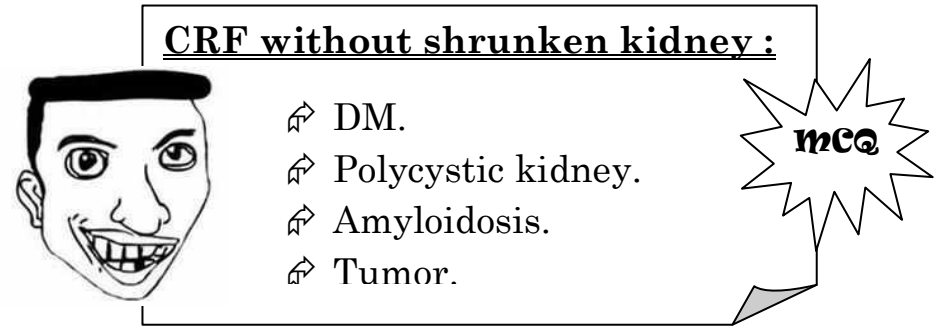
- CBC : Normocytic normochromic anemia.
- Na : ↑ in 80 % , ↓ in 15% of cases.
- K : normal , ↑ in end stage.
- Ca : ↓ , then normal then ↑ in end stage.
- PO_4 : ↑
- H+ : ↑

3- Renal function tests : impaired

- Azotemia : ↑ Urea & creatinine.
- Creatinine clearance : ↓

4- Ultrasound :

- Shrunken kidney .
- Loss of corticomedullary differentiation.



5- Investigations for the cause : e.g. blood glucose.

Stages of CRF :

Stage 1	GFR > 90 ml/min (loss of renal reserve, normal renal function but urine & other abnormalities point to kidney disease)
Stage 2	GFR 60 - 90 ml/min (mild renal impairment)
Stage 3	GFR 30 - 60 ml/min (moderate renal impairment)
Stage 4	GFR 15 - 30 ml/min (severe CRF)
Stage 5	GFR < 15 ml/min (End stage CRF)

Treatment :

I. **D**iet : H_2O , Na , K , Proteins.

II. **D**rugs : symptomatic treatment.

III. **D**ialysis.

IV. Transplant.

I. Diet :

- H2O	- ↑ , usually 3 L/d - Fluid chart 500 C.C. + volume of urine in the previous day.
- Na	- ↓ in 80% of cases. - ↑ in Na losers (20% of cases)
- K	- Normal , but avoid excessive K - ↓ in End stage CRF
- Proteins	- Restricted (40 gm / day)

II. Drugs : (just symptomatic treatment)

GIT :

- Vomiting : domperidone *(motilium)*
- Hiccough : domperidone *(motilium)*
- Gastritis : Ranitidine *(Zantac)*

CVS :

a) Hypertension :
   - Target blood pressure : < 130 / 85 mmHg
   - Regimen : **A**CEIs, methyl dopa , **β** blocker , **C**a channel blocker or **D**iuretic.
   - Hypertension control has been shown to ↓ the progression of CRF.

b) Heart failure :
   - **Di**lator , **Di**gitalis (small dose) , **Di**uretic .
   - **Di**alysis.

c) Pericarditis : Dialysis

d) Arrhythmia : see cardiology.

Chest :

- Chest infections : non toxic antibiotics
- TB : Rifampicin is the safest drug , avoid sterptomycin , Ethambutol are contraindicated.

CNS :

- Neuropathy : vit B_{12}
- Convulsion : Diazepam
- Recurrent attacks of convulsion or coma : dialysis

Skin :

Pruritis : PO_4 binder : $Al(OH)_3$, Antihistaminc.

Bone : Renal osteodystrophy

- PO_4 binder : $Al(OH)_3$, $CaCO_3$. , ↓ PO_4 in diet.
- Active vit D (one-alpha)

Blood :

Anemia :

- Erythropoietin (Eprex) : 4000 u 2 times / week.
- Packed RBCs.

Metabolic & endocrinal :

a) Acidosis : $NaHCO_3$
b) Secondary hyperparathyroidism : parathyoidectomy , ttt of renal osteodystrophy
c) Hyperlipidemia : lipid lowering drugs e.g. colefibrate , statin.
d) Dose of insulin in diabetics : ↓ or ↑ according to the case (*see C/P and you may understand*)

III. Renal replacement therapy : Dialysis and renal transplant.

Indication of dialysis in patients with CRF :

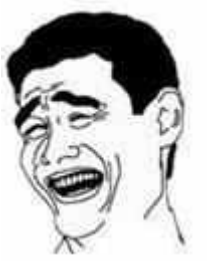
A. Clinical :

- **P**ulmonary edema.
- **P**ericarditis
- **P**ersistent diarrhea.
- **P**reoperative.
- **C**oma.
- **C**onvulsion.
- **D**eterioration of general health.

B. Laboratory :

- Urea : > 200 mg/dl (N : 20 - 40 mg/dl)
- Creatinine : > 8 mg/dl , > 7 in DM (N : 0.7 - 1.2 mg/dl)
- K : > 5.5 mEq/L (N : 3.5 - 5.5 mEq/L)
- HCO3 : < 15 mEq/L
- PH : < 7.15
- Creatinine clearance : < 15 ml / min.

Techniques, complications, contraindications : see later



We are creatures of habit, yet we tend to compete to achieve a greater and better habit, mostly called success. But do remember a successful life lies in the way you set an example to others and how you can change their lives.

Ahmed Mowafy

NEPHROTIC SYNDROME

Definition:

Syndrome characterized by :

1. Heavy proteinuria (more than 3.5 gm/d)
2. Hypoprotinemia (albumin is less than2.5 gm/dl)
3. Generalized edema.
4. Dyslipidemia (elevated cholesterol,TG,.....)

Aetiology:

➲ Primary (80%)

- Minimal change Glomerulonephritis (GN) : in children
- Membranous GN : in adult
- Membranoproliferative GN
- Mesingoproliferative GN

➲ Secondary

- Infection: HBV, Malaria, T.B
- Immune: SLE, PAN
- Metabolic: DM, Amyloidosis
- Malignancy: Lymphoma, M.myeloma
- Vascular: HF, Renal vein thrombosis
- Drugs: Penicillamine, Gold, NSAIDs

Pathophysiology

- Heavy protenuria: due to increased the glomerular permeability.
  - Selective proteinuria: good prognosis
  - Non selective proteinuria: bad prognosis
- Hypoproteinemia: due to proteinuria, GIT edema leading to malabsorption
- Oedema: due to hypoproteinemia, hyperaldosteronism, increased ADH, decreased sensitivity to ANP.

- Dyslipidemia: increased hepatic synthesis stimulated by decreased albumin leading to increased albumin & lipoprotein.
- Na: the total Na is increased due to increased aldosterone But, Na may decreased in blood (escape with edema).
- K: decreased due to increased aldosterone, diuretics, and steroids.
- Ca: decreased bound Ca due to decreased albumin.
  free Ca is normal &maybe decreased.

Clinical picture

Oedema

- Generalized.
- Gradual onset.
- Pitting.
- Puffiness (start periorbital then face then sacrum then genitalia then general)
- Associated with serous effusion.

Hypoproteinemia

- Muscle wasting
- Osteoprosis
- Decreased transferrine leading to anemia
- Loss of immunoglobulins in urine leading to recurrent infection
- Loss of thyroxin binding protein leading to hypothyrodism
- Increased toxicity of drugs

Hypokalemia

- Muscle weakness & paralysis
- Arrhythmia & ECG changes
- Hypokalemic nephropathy

Hypercoagulability

- Due to hypovolemia, loss of antithrombin 3
- DVT leading to PE (sudden death)
- Renal vein thrombosis

No *tetany*.

- Decreased bound Ca only
- Free Ca is still normal in most cases

No *oliguria*.

- Tubular function is normal

No *hematuria*.

No *hypertension* .

N.B

Causes of hypertension in Nephrotic syndrome

- Nephritic nephrotic.
- Collagen diseases.
- D.M
- Steroid.

Differential Diagnosis:

- DD of generalized edema : see later
- DD of proteinuria : see later

Investigations

➲ **Urine examination:**

- Volume: Normal
- Specific gravity: Normal
- Casts: Hyaline & Lipid casts
- Proteinuria: more than 3.5 gm/d

➲ **Blood examination:**

- Increased ESR
- Increased cholesterol, TG, LDH, VLDL
- Anemia
- Decreased Na ,K, Ca

N.B

Total Na is increased But, Na in blood may be decreased (escape with edema)

➲ **Renal function tests:**

- Normal

➲ **Renal biopsy:**

Indications:

- Hypertension.
- Hematuria.

Not indicated in children since diagnosis is minimal change GN

➲ **Investigations for the cause:**

e.g: ❁ ANA for collagen diseases

❁ Blood glucose

Treatment

Diet:

- H2O: it is better to keep the patient in slight –ve balance
- Na: decreased
- K: increased
- Protein: increased (to compensate the loss)

Drugs:

➲ ***Oedema***

- Lasix : it may lead to hypovolemia & ARF
- Spironolactone : to decrease aldosterone.

➲ ***Hypoproteinemia***

- High protein
- ACEIs : decrease proteinuria
- Antibiotic : for recurrent infections

➲ ***Hypokalemia***

- Potassium

- ***Hypercoagulability***
  - Oral anticoagulant
  - Heparin is not used because it acts through anithrombin 3 which is lost in urine
- ***Salt free albumin***
  - In resistant cases
- ***Cortisone*** (60 mg/d for 1m then 30 mg/d for 2m)
- ***Immunosuppressive***
  - Cyclophosphamide
  - Azathioprine

Dialysis:

- Patient passing to renal failure.

Differential diagnosis of polyuria

1. **Physiological** :
   - Winter months.
   - Excess coffee or tea.
   - Diuretics.
2. **Psychological :** Hysterical polydepsia.

	DI	***Hysterical polydepsia***
C/P :	Polyuria then polydepsia	Polydepsia then polyuria
Fluid deprivation test :	polyuria persists	No polyuria
Osmolality	↑↑	↓↓

3. **Pathological** :

a. Endocrinal :
   i. D.I.
   ii. D.M.
   iii. Adrenal : Conn's , Cushing's , Addison's.
   iv. Thyroid : thyrotoxicosis.
   v. Parathyroid : hyperparathyroidism.

b. Renal :
   i. Nephrogenic DI .
   ii. Chronic renal failure
   iii. Diuretic phase of acute renal failure.

c. After any attack :
   i. Migraine
   ii. Epilepsy
   iii. Bronchial asthma
   iv. PSVT.

NEPHRITIC SYNDROME

Definition:

Syndrome characterized by ***acute onset*** of :

- Hypertension.
- High jugular venous pressure (JVP)
- Mild edema.
- Oliguria and ***hematuria.***

Aetiology:

- Post-streptococcal infection (group A beta hemolytic streptococci)

  Upper respiratory tract infection or skin infection ⇨latent period (1-3w)⇨

  Immune complex formation ⇨ deposition in glomeruli ⇨ Glomerulonephritis.

Pathophysiology:

1. **Oliguria:** due to decreased glomerular permeability & narrowing of the afferent arteriole.
2. **Hematuria:** injury of the capillary wall.
3. **Hypertension:**
   - V.C of the afferent arteriole causes increase of renin.
   - Na & H2O retention.
4. **High JVP:** due to hypervolemia (Na&H2O retention).
5. **Odema:** Na&H2O retention, HF, Toxic capillaritis.

Clinical picture:

1- Acute onset.

2- Young age (*usually below 20 ys*).

3- History of streptococcal infection (pharyngitis, pyoderma).

4- General (**F**ever, **H**eadache, **M**alaise, **A**norexia).

5- Local (loin pain & tenderness).

6- Hypertension (acute onset, *never severe* but may lead to complications due to acute onset & young age).
7- Congested neck veins.
8- Mild odema: *periorbital then in the face then generalized*.
9- Oliguria & Hematuria.
10- Anemia: due to bone marrow depression (immune complex).

Complications:

Complications of hypertension ⇨⇨{see cardiology… wait u can see it here ☺}

1-Cardiac :

- **LSHF :** due to pressure overload .
- **Ischemic heart disease :** due to atherosclerosis & hypertrophy .
- **Bernheim effect :** (signs of RSHF)

  Hypertrophy of LV may cause bulging of the septum in th RV → leading to slight impairment of the filling of RV → sig

2-Cerebral :

- Cerebral atherosclerosis .
- Cerebral ischemia & thrombosis (infarction)
- Cerebral hemorrhage (stroke)
- **Hypertensive encephalopathy :**

  As a result of acute rise of BP , the cerebral blood vessels are no longer able to maintain the necessary degree of constriction (*failure of auto regulation*) & they begin to dilate → ↑ cerebral blood flow →↑ ICT , brain edema , coma & convulsion may occur .

NB: ***How to differentiate between stroke & hypertensive encephalopathy?***

- ***Stroke*** *: Signs of lateralization (unilateral)*
- ***Hypertensive encephalopathy*** *: No signs of lateralization (bilateral)*

3-Renal :

- Renal failure .
- Hematuria & proteinuria .

4-Retinal : 4 grades

- Grade I : Thickening of retinal arterioles (*silver wire appearance*).
- Grade II : Kinking of retinal veins .
- Grade III : Hemorrhage & exudates .
- Grade IV : Papilloedema .

5-Vascular :

- **A**therosclerosis .
- **A**ortic dissection .

Investigations:

➲ Urine Examination

- Volume: oliguria (less than 400 ml/d)
- Specific gravity: increased
- Casts: red cell casts
- Hematuria (coca cola like): dysmorphic RBC`S

➲ Blood Examination

- Anemia
- Increased ESR
- Leucocytosis
- Urea & creatinine may be elevated
- Increased Na & K

➲ Renal Function Tests

- Glomerular: impaired
- Tubular: normal

➲ Renal Biopsy

Not needed for diagnosis But, in prolonged cases to exclude other diseases.

➲ **Investigations for the cause**

- Increased ASO titre
- Anti-streptokinase
- Culture (swabs from throat)

Prognosis:

Self limited disease in most of patients.

- 90% : complete recovery.
- 5% : rapidly progressive glomerulonephritis leading to renal failure.
- Few patients : develop acute renal failure, hypertensive encephalopathy &heart failure.

Treatment:

1- **Diet:**

↓ H2O, Na, K, Protein.

2- **Drugs :**

- Treatment of HTN and its complications.
- Antibiotics: crystalline penicillin(1 million u/6h iv for 1w).

N.B

- ✓ Cortisone is contraindicated as it increases blood pressure.
- ✓ Cortisone is indicated only in collagen diseases.

3- **Dialysis:**

5% leads to Acute renal failure.

DIFFERENTIAL DIAGNOSIS OF HEMATURIA

Pre-Renal: (systemic causes)

- **H**emorrhagic blood disorders:
- **H**emorrhagic fever.
- Severe **H**TN.
- **H**eparin.
- **A**ngiomatus malformation.
- **A**neurysm.
- **T**umor.
- **T**rauma.

Renal:

- Nephritic syndrome
- Tumors (*hypernephroma*)
- Stone
- Infection (*pyelonephritis*)

Post RenaL

- Trauma (catheter)
- Stone bladder
- Tumor bladder
- Infection (cystitis)

N.B The most common cause of hematuria is UTI

GLOMERULONEPHRITIS

Definition:

It is an immune mediated *glomerular injury* with symmetrical simultaneous involvement of **both kidneys** at the same time.

Etiology:

- **Primary:** Idiopathic, No Systemic Involvement
- **Secondary:** as a Part Of Systemic Disease

1) Infection:
- ***Bacterial*** (e.g. post-streptococcal)
- ***Viral*** (e.g. HBV, HCV, CMV)
- ***Parasitic*** (e.g. Schistosoma mansoni, malaria).

2) Collagen diseases (e.g. SLE, polyarteritis nodosa, Rheumatoid Arthritis).

3) Drugs (e.g. Penicillamine, Paradione, Aspirin, Heroin).

4) Metabolic disease (e.g. Diabetes mellitus, amyloidosis).

5) Malignancy (e.g. lymphoma).

6) Heredofamilial (e.g. Alport's syndrome).

PATHOGENESIS OF GLOMERULONEPHRITIS:

Many pathogenic mechanisms are responsible for the development of glomerular injury.

These mechanisms are:

1- Metabolic Abnormalities: See diabetic nephropathy, gouty nephropathy

2- Hyperfiltration injury: See diabetic nephropathy. (Endocrine book)

3- Hereditary Abnormalities: Alport's Syndrome.

4- Immunologic Mechanisms:

Most of the cases of glomerulonephritis are secondary to immunologic attack affecting the renal glomeruli. This attack usually occurs in genetically predisposed person after exposure to toxin or an infection. This will provocate the immune system to attack the glomerular structures. This could be through the formation of antibodies or through a cell mediated glomerular injury.

Classification of Glomerulonephritis:

1. **Minimal change (lipoid nephrosis)**

   No abnormality or minimal increase in mesangial cellularity. this lesion usually clinically presents as steroid sensitive nephrotic syndrome with good prognosis.

2. **Focal and segmental glomerulosclerosis**

   Sclerotic lesions, these lesions involve only parts of the affected glomeruli (i.e. *segmental*) and some glomeruli look normal, but in between a glomerulus is affected.

   This disease usually presents with Nephrotic Syndrome.

3. **Membranous Glomerulonephritis**

   Diffuse thickening of the glomerular capillary basement membrane with no proliferation in the mesangium.

   This disease usually presents as Nephrotic Syndrome.

4. **Proliferative glomerulonephritis:**

According to the site of proliferation within the renal glomeruli, this type could be sub-divided into:

a) Mesangial proliferative Glomerulonephritis

There is an increase in mesangial matrix and mesangial nuclei by light microscopic examination.

This disease usually presents with Hematuria or with Nephrotic Syndrome.

b) Membranoproliferative Glomerulonephritis

There are both diffuse thickening of glomerular capillary wall and mesangial proliferation.

This disease may present as Nephrotic Syndrome

c) Crescentic Glomerulonephritis

There is extensive cellular proliferations in the Bowman's capsule giving the appearance of crescent surrounding the glomerular tufts.

This disease is serious and usually presents as rapidly progressive glomerulonephritis.

d) IgA nephropathy:

The commonest glomerular disease presenting with gross or microscopic haematuria. a proliferative type of glomerulonephritis characterized with predominant immunoglobulin A deposition in renal glomeruli.

Clinical manifestations of Glomerulonephritis

1. Nephrotic syndrome.
2. Acute nephritic syndrome (acute nephritis)
3. Rapidly progressive Glomerulonephritis.
4. Acute renal failure.
5. Chronic renal failure.
6. Asymptomatic urinary abnormality.

Investigations:

- Urine analysis
- Renal function tests
- Renal biopsy
- Renal imaging : CT, U/S,….
- Blood investigations:
- Investigation for the cause:
- Serology, hepatitis markers & blood glucose

LUPUS NEPHRITIS

- Lupus nephritis can be manifest by syndromal picture (proteinuria , nephritic syndrome , ARF , CRF) but proteinuria is present in almost all patients.
- Note that drug induced SLE only rarely affects the kidneys.
- Furthermore, patients may suffer from other symptoms of lupus unrelated to kidney function e.g. arthralagia , fevers , fatigue, psychosis ……
- Renal biopsy should be considered in any patient with SLE who has clinical or laboratory evidence of active nephritis.
- **Classification of lupus Glomerulonephritis** :

Class I : Minimal change GN	- Mild proteinuria.
Class II : Mesangioproliferative GN	- Asymptomatic hematuria or proteinuria. - This form typically responds completely to treatment with corticosteroids.
Class III : Focal proliferative GN	- Often responds to treatment with high doses of corticosteroids.
Class IV : Diffuse proliferative GN	- This form is mainly treated with corticosteroids and immunosuppressive drugs.
Class V: Membranous GN	- Characterized by extreme edema and protein loss.
Class VI : Sclerosing GN	- Significant renal insufficiency or end-stage renal disease in most cases; unlikely to respond to medical therapy.

METABOLIC ALKALOSIS

- **Etiology :**
  a) **H+ ion loss :**
     i. **GIT loss** : Vomiting , Gastric aspiration.
     ii. **Renal loss** :
        - Conn's , Cushing's .
        - Loop or thiazide diuretics.
        - Hypokalemia (*Intracellular shift of H^+ ion*)

  b) **HCO3 retention :**
     Alkali ingestion : Antacids with $NaHCO_3$, milk alkali syndrome.

Metabolic alkalosis is traditionally classified as :

Cl-responsive alkalosis :
- Characterized by urinary chloride < 15 mEq/L → indicating Cl depletion.
- e.g. Loss of HCL , Diuretics.

Cl-resistant alkalosis :
- Characterized by urinary chloride > 25 mEq/L
- Caused mainly by hyperaldosteronism or hypokalemia (these 2 conditions often co-exist)

- **Clinical picture :** **4**
  - Shallow respiration.
  - Tetany.
  - Clinical picture of the cause.
  - Hypokalemia. (….)
- **Investigations :**
  - ↑ PH , ↑ H^+ , ↑ HCO_3
- Investigations for the cause.
- **Treatment :**
  - Treatment of the cause.
  - NaCl , KCl or HCl

METABOLIC ACIDOSIS

Etiology : ↑ H^+ or ↓ HCO_3

d) **↑ H^+ ions :** (*High anion gap*)
- o DKA.
- o Lactic acidosis.
1. End stage CRF.
2. Aspirin toxicity.

e) **↓ HCO_3 :** (normal anion gap)
- o Diarrhea.
- o Pancreatic fistula.
- o Renal tubular acidosis.

Anion gap (AG) : Na^+ - (Cl + HCO_3)
- o It means unmeasured anions.
- o Normal value of AG : 12 ± 4 (8 - 16 mEq/L)
- o It is used to determine if a metabolic acidosis is due to ↑ H^+ or loss of HCO_3 :
  i. High anion gap : The cause is ↑ H^+
  (H^+ ions combine with HCO3 to for H2CO3 → ↓ HCO3 → High AG)
  ii. Normal anion gap : The cause is ↓ HCO_3
  (↓ HCO_3 is counterbalanced by ↑ CL so AG is normal)

Clinical picture : 4
- Rapid deep respiration.
- Myocarditis.
- C/P of the cause e.g. DKA
- Hyperkalemia (…….)

Investigations :
- o ↓ PH , ↓ H^+ , ↓ HCO_3
- o Investigations for the cause.

Treatment :
- o Treatment of the cause e.g. DKA
- o $NaHCO_3$

HYPOKALEMIA

< 3.5 mEq/L

Etiology :

1- **Intracellular shift** :

- Insulin.
- Adrenaline.
- Alkalosis.
- Hypothermia.

2- **Renal K loss** : (Urine K > 30 mEq/L)

- Diuretics : Lasix , thiazides .
- Mg depletion.
- Alkalosis.
- Conn's , Cushing's diseases.
- Nephrotic syndrome.

3- **Extra renal K loss :** (urine K < 30 mEq/L)

- Diarrhea , vomiting.
- Aspiration of ascetic fluid.

Clinical picture of hypokalemia :

- Asymptomatic (2.5 - 3.5 mEq/L)
- Skeletal *muscles* : Weakness , flaccid paralysis .
- Smooth *muscles* : Paralytic ileus.
- Cardiac *muscles* :
  - ECG changes : Prominent U wave , Prolonged QT interval.
  - Arrhythmias : may be due to associated conditions e.g. ↓ Mg , digitalis toxicity.
- CNS : ↓ mentality.
- Renal : Tubulo-interstitial damage.

Investigations :

- K < 3.5 mEq/L
- ECG.
- Investigations for the cause.

Treatment :

K replacement : KCL , Potassium phosphate.

- Notice that total body potassium = 3500 mEq
- 1 mEq/L decrease in serum K = 10% deficit of total body potassium (350 mEq)
- Full replacement usually takes few days.
- Refractory hypokalemia : Hypomagnesemia should be treated.

HYPERKALEMIA

> 5.5 mEq/L

Etiology :

1- **Extra-cellular shift :** **A B C D**

- **A**cidosis.
- **β** blockers.
- **C**onvulsion.
- **D**igitalis toxicity.

2- **Impaired renal excretion** :

- Acute renal failure.
- End stage chronic renal failure.
- Nephritic syndrome.
- Addison's disease.
- Drugs : **A**CEIs , **A**spirin.

3- **Massive blood transfusion**.

Clinical picture :

I. Skeletal muscles : weakness , flaccid paralysis.

II. Cardiac muscle :

1) Arrhythmias , heart block & cardiac arrest.
2) ECG changes :
   - Tall peaked T wave.
   - Wide QRS.
   - Prolonged PR intervals.
   - Flat P wave.

III. Clinical picture of the cause.

Investigations :

- K > 5.5 mEq/L
- ECG.
- Investigations for the cause.

Treatment :

- Insulin - Dextrose (10 U insulin in 500 ml 20% dextrose) : intracellular shift.
- Ca gluconate : in severe hyperkalemia (> 7mEq/L) to protect the heart , but contraindicated if hyperkalemia is due to digitalis toxicity.
- Acidosis correction : by HCO_3
- Frusemide (lasix) : ↑ excretion.
- Hemodialysis.

If you can't explain it simply, you don't understand it well enough

Albert Einstein

HYPERNATREMIA

> 145 meq /l

Etiology: (4)

1. ↓H2O intake : old age.

2. Hypotonic fluid loss : **3D**

- **D**iarrhea , vomiting , sweating.
- **D**I.
- **D**M.

3. Na retention : **4C**

CRF , **C**onn's , **C**ushing &**C**irrhosis.

4. Hypertonic fluid gain.

Clinical picture : (4)

1. *Feature of the cause :* CRF , Cushing.....
2. *general:* polydepsia , nausea ,vomiting & Muscle twitches, ...
3. *neurological*

➲ **C**onfusion, **C**onvulsions, loss of **C**oncentration, coma, **I**rritability

4. *depends on ECV* (**E**xtra-**C**ellular **V**olume)

- In hypervolemic hypernatremia
  - Manifestations of hypervolemia (*and mention*)
- In hypovolemic hypernatremia
  - Manifestations of hypovolemia : hypotension

Treatment: (4)

- ↓Na intake
- Hypotonic fluid infusion
- Hypotonic saline + lasix in hypervolemic hypernatremia
- Ttt of the cause

NB slow correction to prevent brain edema

HYPONATREMIA

<135 meq/l

Etiology:

1. ↑H2O intake: hysterical polydepsia
2. Overhydration : (*water intoxication*)
   - SIADH
   - ARF :if excessive fluid are given
   - Edematous condition:
     - Nephritic, CHF , LCF
3. Na loss:
   - Renal : Addison , diuretics
   - GIT : vomiting diarrhea
4. Excessive hypotonic saline

Clinical picture:

The same as hypernatremia ☺

Treatment:

- ↑ Na intake.
- Hypertonic saline + lasix in a case of hypervolemia.
- Treatment of the cause.

ACUTE PYELONEPHRITIS

Definition : Acute infection of the kidney & pelvis of the ureter.

Causative organisms :

- Gram -ve bacilli :
  - E.coli.
  - Klebsiella , Pseudomonas , Proteus.
- Gram +ve cocci :
  - Staph. aureus.
  - Strept. fecalis.

Route of infection :

- Ascending infection: from lower urinary tract. (the most common)
- Hematogenous route: bacteremia (infective endocarditis)

Predisposing factors :

- Sex : ♀ > ♂ (hormones , short urethra , pregnancy → stasis , dilated ureter)
- Stagnation of urine : due to obstruction (stones , strictures , enlarged prostate).
- Impaired immunity : DM , Extremes of age.
- Introduction of infection : Catheterization , Cystoscopy , Honeymoon cystitis.

Pathology : unilateral or bilateral

- Inflammation of the mucous membrane of the ureter.
- Inflammation of renal medulla.

Clinical picture :

i. General : FHMA (**Fever** with rigor , Headache , Malaise , Anorexia)
ii. Urine : **Dysuria** , Frequency & urgency.
iii. **Loin pain** & tenderness : of acute onset & radiating to groin.

Complications :

- Perinephric abscess.
- Pyonephrosis.
- Septicemia.
- Acute renal failure. (rare)
- Recurrence → chronic pyelonephritis.

Acute Necrotising papillitis :

- Severe form of infection occurs in the presence of obstruction , DM , sickle cell disease.
- Pathology : renal papillae are susceptible to necrosis (↓ blood supply)
- C/P : The same as pyelonephritis plus hematuria , urinary tract obstruction & ARF.

Investigations :

1- Urine examination :

d) Urinalysis :

- Volume : normal (*rarely oliguria in cases complicated by ARF*)
- PH : Acidic in most cases (E.coli) , Alkaline in proteus infection.
- Proteins : mild proteinuria.
- Pus cells , Epithelial cells , RBCs
- Casts : WBCs casts , epithelial casts , hyaline casts.

e) Urine culture & senistivity test : Bacterial count > 100,000 colony /ml.

2- Blood examination :

- Leucocytosis.
- ESR : ↑

3- Renal function tests : normal (except in cases complicated by ARF)

4- Renal imaging :

- Ultrasound : may detect stones , perinephric abscess.
- IVP & cystoscopy : to detect the predisposing factors especially in recurrent cases.

Treatment :

- Diet : light nutrient diet.
- Drugs :
  i. Antibiotics :
    - Before the result of urine culture : a broad spectrum antibiotic is given
      - Amoxicillin : 500 mg/8h
      - Co-trimoxazole : 2 tab/12h
      - Quinolones : Ofloxacin 200 mg/12h
      - Tetracycline.
    - Recurrent or resistant cases : treated according to the result of culture & sensitivity test e.g. Pseudomonas : pipracillin 1 gm/6h
    - Duration of therapy : usually 2 - 3 weeks.

  ii. Change the urine PH :
    - If acidic as in E. coli : $NaHCO_3$ 2 gm t.d.s.
    - If alkaline as in proteus : Ascorbic acid 1 gm/d.

  iii. Symptomatic treatment : analgesics & antipyretics.

CHRONIC PYELONEPHRITIS

Etiology :

- Recurrent attacks of acute pyelonephritis.
- It usually occurs in patients with underlying abnormalities e.g. urinary obstruction , vesico-uretric reflux , impaired immunity.

Pathology :

- Unilateral or bilateral.
- If bilateral ⇨ asymmetrical.
- The affected kidney is small with irregular surface & adherent capsule.

Clinical picture :

1. Recurrent attack of acute pyelonephritis (*fever , dysuria , loin pain*).
2. Proteinuria due to tubular dysfunction.
3. Chronic renal failure.

Investigations :

1. Urine analysis :
   - Pus cells (**pyuria**) & casts.
   - Proteinuria.
   - In late stages : similar to cases of chronic renal failure.
2. Blood examination :

   Anemia , Leucocytosis , ↑ ESR.
3. Renal function tests :

   Tubular functions are impaired more than glomerular functions.
4. Renal imaging e.g. ultrasound
   - **S**mall kidneys (*usually unequal*).
   - **S**tones , **s**trictures.
5. Investigations for the cause :

   Culture & sensitivity test.

Treatment :

1. Antibiotic therapy :
   - Selection of antibiotics is based on *culture & sensitivity test*
   - The dose is reduced due to impaired excretion of drugs.
   - Prolonged & repeated courses of treatment may be needed.
2. Correction of the predisposing factors e.g. stones.
3. Treatment of chronic renal failure & hypertension if present.
4. Unilateral nephrectomy : is rarely indicated in advanced unilateral cases.

⇨ Great talkers are little doers.
⇨ A monkey in silk is a monkey no less.
⇨ Friendship is love with understanding.

ENGLISH PROVERBS & SAYINGS

VALUE OF URINE EXAMINATION

Physical

Colour

- Normally: amber yellow
- Colorless: polyuria
- Dark brown: obstructive jaundice
- Black: alkaptonuria
- Golden yellow: fagyl
- Milky: pyuria,chyle
- Red:
  - Heamaturia, Hemoglobinuria,
  - Cyclophosphamide,Rifampicin.
  - Food dyes

Volume of urine

- Normally: 800-2000 ml/d
- Polyuria: more than 2 L/d. (*DD see below*)
- Oliguria: less than 400 ml/d. (ARF,end stage CRF,Nephritic syndrome)

Specific gravity

- Normally: 1015-1025
- ↓ all causes of polyuria except D.M
- ↑ all causes of oliguria except ARF(**1010 fixed**)

PH

- Normally: 5.5-6.5 (average 6)
- Acidic: vitamin C,E
- Alkalaine: Na bicarbonate

Chemical

Protein content

- Proteinuria: (*DD see below*)

Sugar

- ↑D.M

Keton bodies

- ↑ DKA

Electrolytes

- Na , ↑ K : conn`s disease & cushing syndrome.
- ↑Na , ↓K : Addison`s disease.

Microscopic examination

Hematuria (*see before)*

The most common cause of heamaturia is U.T.I

Painless heamaturia is more dangerous than painfull heamaturia because it may be due to:

- AGN
- Cancer (Renal, Bladder)

Pyouria

- Pus cells: dead polymorph.
- Normal: 4/HPF
- Etiology: acute and chronic ***pyelonephritis***.
- C/P: Fever,dysuria,loin pain & pus.

Sterile pyouria:

- Infection with treatment by antibiotic.
- T.B
- Inflammation (AGN).
- Graft rejection.
- Stones

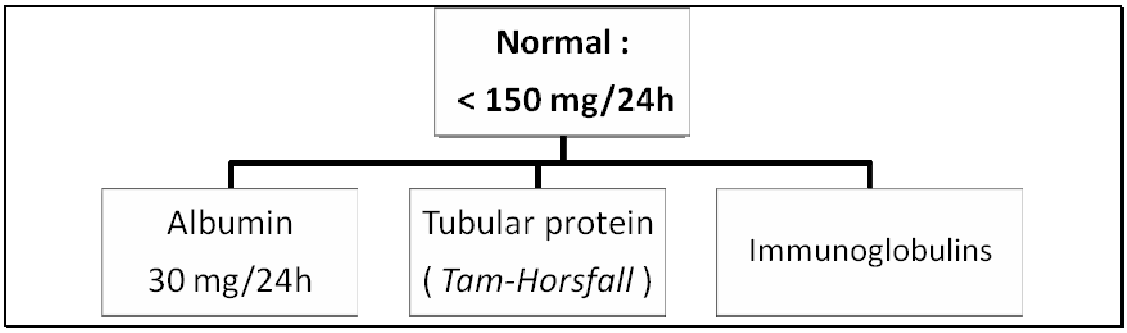
Cast

Formed of:

- Mucoprotein
- Albumin
- Cells: RBC`S, WBC`S, Necrotic epithelium, Granular epithelium

PROTEINURIA

Definition : Presence of more than 150 mg of proteins in 24 hours urine.



Etiology :

I. ***Glomerular diseases :*** *(increased permeability ⇨ leading to leakage of plasma proteins)*

a) 1ry GN :

- Minimal change GN.
- Membranous GN.
- Membranoproliferative GN.
- Focal segmental GN.
- IgA nephropathy.

b) 2ry GN :

- **DM** (*diabetic nephropathy*)
- SLE (lupus nephritis)
- Renal transplant rejection.

c) Disturbed renal hemodynamics :

- Anemia ⇨ hypoxia ⇨ ↑ capillary permeability.
- Fever ⇨ hyperkinetic circulation ⇨ ↑ capillary permeability.
- Congestive heart failure ⇨ renal congestion.

II. *Tubular :* *(decreased tubular reabsorption)*

- Pyelonephritis.
- Interstitial nephritis.
- Fanconi syndrome (*disorder in which the proximal tubular function is impaired*) .

III. *Overflow :* *(increased low MW protein production e.g. Bence-Jones proteins)*

- **A**myloidosis.
- **M**ultiple myeloma.
- **M**yoglobinuria.
- **M**alignancy e.g. lymphoma.

IV. *Functional :*

- Severe exercise.
- Orthostatic : Tall stature , prolonged standing & pregnancy.

V. *False :*

- Pus , semen , vaginal discharge in urine.
- Lifting dipstick for long time.

- **Transient proteinuria :** associated with fever , exercise or stress .
- **Orthostatic proteinuria :**
  - It is an intermittent proteinuria associated with activity & upright posture especially in tall young adult . Renal function tests is normal.
  - Albuminuria usually is less than 1g/24h & protein testing negative on early morning urine specimen.

Clinical picture of proteinuria :

depends on the amount & duration

- Asymptomatic.
- Frothy urine.
- Manifestations of hypoprotinemia : edema , ascites, ….
- Manifestations of the cause : e.g. **Neprotic syndrome** , DM , ….

Analysis of proteinuria :

1) Is it proteinuria ? > 150 mg / d
2) How is detected ?

I- Dipstick test :

- It is most sensitive to the presence of albumin and is much less sensitive to other proteins, such as the light chains of Bence Jones protein.
- It detects albumin only in a concentration above 300 mg/24h.
- Grades : 0 , 1+ , 2+ , 3+ , 4+

False +ve :

- Alkaline urine (urine PH > 7.5)
- Lifting dipstick for long time.
- Pus , semen , vaginal discharge.
- Small amounts of proteinuria in an oliguric patient may give the false appearance of high-grade proteinuria.

False -ve :

- Polyuria.
- Bence-Jones : detected by electrophoresis.
- Urine PH : acidic.

II- 24 hour urine collection for Protein Excretion.

Collection must be done by discarding the first morning void and collecting the voids for the next 24 hours, including the first morning void the next day.

III. Albumin to Creatinine Ratio : (random sample)

- Normal ratio : < 30 mg/g (*30 mg albumin to 1 gram creatinine*)
- Microalbuminuria : 30 - 300 , Macroalbuminuria : > 300
- More accurate than 24 hour urine protein collection.

3) Types of proteinuria :

1- Microalbuminuria	30 - 150 mg/24h
2- Mild	150 - 500 mg/24h
3- Moderate	500 - 1000 mg/24h
4- Heavy	1000 - 3500 mg/24/h
5- Nephrotic range	> 3500 mg/h

4) Is it glomerular or not ?

- > 2 g/24h : glomerular disease likely.
- Nephrotic range (> 3.5 g/24h) : always glomerular.

5) Selective or not ?

- Selective : albumin > 85 % → good prognosis.
- Non selective : albumin & globulin → bad prognosis.

Investigations :

- Urinalysis : to detect proteinuria (see above)
- Investigations for the cause e.g. **nephrotic syndrome** , DM.

Treatment : Treatment of the cause e.g. **nephrotic syndrome**, DM.

Studying medicine without teacher is like sailing without a boat, and studying Internal medicine without ***Dr/Ahmed M. Mowafy*** *is like not going to the sea at all.*

Dr. Alsayed Dawoud
Kasr-Alainy school of medicine.

I-Nephrology MCQ

1- In which one of the following , renal excretion of water most likely to be increased:

a) Chronic renal failure.
b) Early phase of acute tubular necrosis.
c) Nephritic syndrome.
d) Hypocalcemia.
e) Secondary hyperaldosteronism.

2- The following are features of diabetic nephropathy EXCEPT :

a) Glomerular hyperfiltration
b) Microalbuminuria
c) Diffuse glomerulosclerosis
d) Nodular glomerulosclerosis
e) Bilateral contracted kidneys

3- Which one of the following is an accurate statement regarding renin ?

a) Decrease renin release increase thirst
b) Decreased renin release leads to vasoconstriction
c) Renal cortical ischemia does not lead to increased renin release
d) Renin release decreases in response to Na depletion
e) Renal Sympathetic nervous stimulation causes increased renin relese

4- Which one of the following in a patient with acute renal failure indicates the most urgent need for dialysis ?

a) Astrixis
b) Hiccough
c) Hyperkalemia of 6 mEq/ L
d) Pericarditis with a pericardial rub
e) Peripheral neuropathy

5- Which of the following is true for most patients with moderate chronic renal failure :

a) Very low protein diet
b) The diet should be high in cholesterol
c) Dairy product are a useful source of calcium
d) Fluid intake should be 2 – 3 litres per day
e) The diet should be high in K.

6- Typical features of acute post infectious gromerulonephritis include <u>EXCEPT</u>

a) Hypertension
b) Impaired renal tubular function
c) Hypocomplementaemia
d) Oliguria
e) Hematuria

7- Microscopic hematuria would <u>not</u> be an expected finding in :

a) UTI
b) Infective endocarditis.
c) Membranous GN
d) Renal infarction.
e) Renal papillary necrosis.

8- Typical feature of the nephrotic syndrome include <u>EXCEPT</u> :

a) Bilateral renal angle pain
b) Generalised edema and pleural effusion
c) Protinuria > 3.5 gm / d
d) Na retention.
e) Normal urine volume

9- Typical biochemical features of chronic renal failure include :

a) Hypophosatemia
b) Hypercalcemia
c) Proteinuria > 3.5 gm/d
d) Impaired urinary concentrating ability.
e) Specific gravity of the urine is markedly increased

10- Complications of chronic renal failure include <u>EXCEPT</u> :

a) Microcytic anemia
b) Peripheral neuropathy
c) Bone pain
d) Pericarditis
e) Metabolic alkalosis

11- Which one of the following is <u>NOT</u> indicated in initial treatment of hyperkalemia ?

a) IV Ca.
b) IV glucose & insulin.
c) Dialysis.
d) Na polystyrene sulfonate.
e) Beta blockers.

12- A 36 year old hypertensive man develops macroscopic hematuria 24 hours after the onset of pharyngitis. The patient's brother had a history of post streptococcal GN at age of 6 after a streptococcal infection of the throat.

- What is the most likely explanation for this patient's hematuria ?

a) Post streptococcal GN.
b) Glomerulosclerosis.
c) IgA nephropathy.
d) Henoch- Schonlein purpura.
e) Renal vein thrombosis.

II.

- As regard to <u>diet</u> in renal diseases :

	CRF	ARF	Nephrotic	Nephritic
H2O				
Na				
K				
Protein				

- As regard to electrolyte disturbance :

	CRF	ARF	Nephrotic	Nephritic
<u>Urine :</u> Volume :				
Specific gravity				
Specific cast				
<u>Blood :</u>				
Na :				
K :				
Ca :				

